

WATER QUALITY MANAGEMENT PRACTICES ON FOREST LAND



Michigan Department of Natural Resources **DNR** 

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Preface

"Water Quality Management Practices on Forest Land" serves as a guide for owners of forested land, describing responsible actions necessary to maintain the high quality water normally associated with their land. All earth changes (people's uses and activities) have potential for negative impacts on water quality. Forest land management activities, such as road construction and maintenance, use of log landings, site preparation, mechanical tree planting, etc., certainly have potential for causing erosion, stream sedimentation, and other undesirable impacts on water quality. This manual provides guidance for the landowner, forester and timber producer to plan their activities with protection of ground water and surface water in mind.

This manual is not a cookbook in which the user can find recipes for the multitude of possible situations involved in forest land activities. Neither is it a guide for prescribing silvicultural practices, nor does it attempt to set a preference of one owner's management objectives over another's objective. It does describe practices which are known to be effective in controlling erosion and minimizing impacts on the quality of surface and ground water on forest land.

This manual of Best Management Practices is a part of "Michigan's Nonpoint Source Pollution Control Management Plan". It was developed with the guidance of a Forest Land Technical Committee. The Committee was made up of representatives from the following organizations and interest groups: Michigan Association of Conservation Districts; USDA: Natural Resources Conservation Service, and Forest Service; Michigan State University, Department of Forestry and the Center for Remote Sensing; Michigan Technological University, School of Forestry; Michigan Association of Timbermen; Michigan Forest Association; Forest Products Industry; Michigan Department of Agriculture; Michigan Department of Natural Resources: Fisheries Division, and Forest Management, Michigan Department of Environmental Quality: Surface Water Quality Division.

Users of this manual are encouraged to suggest improvements to it by contacting the State Forester, Michigan Department of Natural Resources, Forest Management 517-373-1275, or Michigan Department of Environmental Quality, Surface Water Quality Division, P.O. Box 30273, Lansing, MI 48909, phone: 517-373-1949.

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INTRODUCTION

A. BACKGROUND

Michigan, "The Great Lakes State", has within its borders 40,000 of the 95,000 square miles of Great Lakes, the largest body of fresh water in the world. In addition, Michigan's land mass includes 11,000 inland lakes and 36,000 miles of rivers and streams. Water, clean water, is one of our greatest natural assets.

Another great natural asset, a resource that is directly related to clean water, are the 18 million acres of forested land. Those forests, about one-half of the State's land area, are owned by many people. The largest owner group is the 385,000 individuals whose private holdings range from a few acre woodlot to tracts of several thousand acres. Fifty-three percent of Michigan's forested acres are held by this group. The next largest ownership class is the public forest lands (state = 20% and federal = 15%). The forest products industry owns the remaining 12%.

The management practices on our forest lands, by all those owners, will determine if the forests remain healthy and productive in perpetuity. It is true that healthy, stable and productive forests are closely associated with the highest quality of surface and ground water. It is also true that forest management practices which can cause erosion, are serious threats to surface water quality. Other uses and activities can also have long term impacts on ground water.

B. PURPOSE

This manual is based on the recognition that forest land uses can degrade surface and ground water by introducing the following major pollutants: sediment (mineral and organic), nutrients, chemicals, heat and debris. The purpose of this manual is to assist the forest landowner and persons who do the management work on the ground. It provides many specific recommendations on how to avoid polluting the water associated with forest land. Planning for a road system and stream crossing structures, allowing for stable buffer strips, erosion control devices and seasonal constraints on operations are all focused on maintaining high quality water. Water quality protection considerations must be included in the development of all management plans of forest landowners.

C. THE USERS OF THIS MANUAL

The management of forest lands most often involves three distinct interests, i.e., the landowner, the professional forester/resource management expert and the timber producer or work crew who make things happen in the forest. This manual is intended for all three of those interests or functions, recognizing that more than one function may be represented by a single person. The combination of all three perspectives (the owner, the forester, and the logger) is necessary for a bona fide commitment to preserve clean water in the forests of Michigan.

Forest landowners and their agents and contractors are responsible for any damage to streams, lakes, and wetlands resulting from any aspect of a logging operation. All aspects of environmental degradation are covered by existing laws in Michigan. Violation of those statutes or failure to secure the necessary permits can result in significant penalties to the landowner.

CHAPTER 1. Timber Harvesting – Planning and Operational Considerations with Respect to Water Quality.

Timber harvesting, other silvicultural treatments and wildlife habitat treatments on forested lands are a vital and integral part of management of the forest resources. The treatments generally contribute to a healthy and vigorous forest and thereby perpetuate the land use which has the greatest potential for high water quality in the long-term. Timber harvesting includes felling, forwarding, skidding, sorting, loading and hauling of timber products. Harvest operations require haul roads, log landing and skid trails to be developed and maintained.

The considerations described below apply whenever and wherever the forest landowner includes timber harvesting in the management objectives of the ownership. Timber harvesting includes considerations of pre-harvest planning, forest land roads, equipment operations and maintenance and buffer strip designation and maintenance. Similar considerations apply to other types of treatments. The provision of buffer strips along all streams and bodies of water, both permanent and intermittent, is a most critical practice in the protection of forest land water quality. Even if an erosion control device fails, a properly functioning buffer strip of sufficient width can protect the adjacent stream from sedimentation. (See Table 5, and Chapter 5, A.1., 3., 4. and 5. B.-G.)

A. PRE-HARVEST PLANNING

Pre-harvest planning is the collection of information about the area to be harvested and the use of this information to determine the best time and method to harvest. The plan includes the road and skid trail systems, operational impacts on the physical site, pre-harvest preparations, and the management practices necessary.

The pre-harvest plan includes a map identifying: property boundaries, streams and drainages, soils, slope, and critical environmental concerns, approximation of main haul road and skid trail locations, potential log landings, stream or drainage crossings, and buffer strip designations. A narrative identifies road and trail specifications along with amount and size of machinery for harvest and removal of timber products. Timing of harvest and timber sale contract condition is included.

B. FOREST LAND ROADS

The details of management practices related to road system planning, haul road construction and maintenance, skid trails and log landings are contained in Chapter 2.

C. EQUIPMENT OPERATIONS AND MAINTENANCE

Timber harvesting utilizes fuels and lubricants for a variety of equipment to accomplish field operations. Precautions are needed to prevent water contamination when using fuels, lubricants and other materials associated with heavy equipment operations.

The remote locations that are typical of most forestry operations result in many on-site maintenance activities. The equipment operator must constantly guard against spills of fuels, lubricants or other toxic materials. Proper equipment maintenance, including routine checks of hoses and fittings, is the key to protecting surface water and ground water resources from the impacts of fuel and lubricant spills and leaks.

Common sense, care, proper planning and the anticipation of problems that may occur can eliminate or reduce potential water quality problems arising from spills. The following precautions should be adopted for all activities requiring equipment operations.

(See Table 5, and Chapter 5, A.2. & 3., G.)

1. Provide receptacles in maintenance areas or in vehicles for collecting solid wastes such as empty grease tubes, oil filters and other trash. The materials collected in these receptacles must be disposed of properly at an approved solid waste site. Empty oil barrels should be recycled or properly disposed of as solid waste at an approved land fill.
2. Locate fueling areas away from water bodies and drainage structures and at locations where a potential spill can be contained and properly treated. This will minimize chance of surface water or ground water contamination. Where a spill does contaminate soil, the contamination material must be removed from the site and deposited at a facility licensed for that purpose.

3. Designate a specified area for draining lubricants from equipment during routine maintenance. The area should allow all waste lubricants to be collected and stored until transported off-site for recycling, reuse or disposal at an approved site. Maintenance activity should not occur while equipment is located in water bodies, floor plains or wetlands. (See Table 5, and Chapter 5, A.2. & 3., G.)
4. Provide maintenance vehicles with the equipment necessary to collect and store lubricants drained during repair activities. Breakdowns could require lubricants to be drained from equipment at locations away from the designated collection area.
5. When spills of fuels or lubricants do occur, if the spill is large, an emergency situation may exist. An operator or any member of a logging crew must be prepared to take action to keep the spill from spreading and entering the water courses on the site. An emergency spill should be reported to the Pollution Emergency Alerting System (PEAS), phone: 1-800-292-4706. Additional contracts may be necessary or desirable, depending on the location and spill situation. It is recommended that for each logging site a Spill Response Plan Sheet, see Exhibit 1, page 73, be completed and made available to all members of the crew.

D. BUFFER STRIPS

Buffer strips, sometimes called filter strips, are areas on both sides of perennial or intermittent streams and around the perimeter of bodies of water where extra precaution is used in carrying out forest practices. One of the purposes of a buffer strip is for water quality protection to provide a zone of intact vegetation to interrupt water flow and to trap and filter out suspended sediments, nutrients, chemicals and other polluting agents before they reach the body of water. Buffer strips also shade small bodies of water, thus reducing thermal pollution. That part of the buffer strip nearest the stream bank can also make an important contribution to the aquatic food chain. Stable, large wood in the stream, organic materials such as leaves and insects falling into the stream all contribute food energy for aquatic life.

Buffer strips should be maintained along all perennial and intermittent streams, lakes or ponds where management activities cause surface disturbance, where soil has been exposed and surface runoff will cause erosion and transport sediment.

Landowners considering forest practices in or near a buffer strip must plan carefully to assure that the function of the buffer is maintained. Those unsure of the water quality impacts of a planned activity should seek the advice and assistance of foresters, biologists or private consultants familiar with such impacts, or otherwise leave the area undisturbed. Any variation to an

undisturbed buffer strip should take into account the following site-specific factors which may affect water quality: waterbody characteristics, slope, soil type, aesthetics, existing vegetation, stream shading, growing season; time of year activity would occur, snow cover or frozen conditions, availability of large woody debris, precipitation, and wetness of soil.

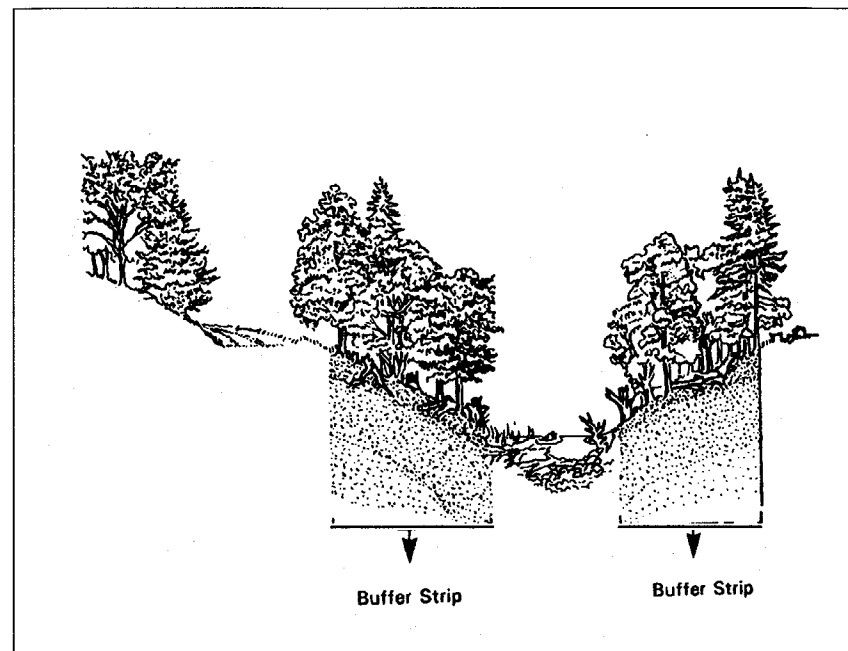


Figure 1. Buffer Strip Illustration

The water quality function of buffer strips can be maintained by meeting the following specifications:

1. The minimum buffer strip width should be 100 feet, from each side of a stream, measured from the bank of the lake or stream. Strip width should be increased with increase in slope percent as shown in Table 1. The strip width shown in the table may need to be increased where domestic water supply could be impacted. Strip width may have to be increased along designated state and federal "Natural" and "Wild and Scenic Rivers". (See Chapter 5, A. 1. g.)
2. Minimize disturbance of the forest floor in buffer area.
3. Harvesting/cutting specifications should be modified to retain a sufficient number of trees to maintain shading of the stream and to leave a stable, undisturbed forest floor.
4. Locate haul roads outside of buffer strip. Where a road must cross a

stream, it should do so at right angles using culverts or bridges.

(See Table 5, and Chapter 5, A.1., 2., 3., 4., B.3.)

5. Locate equipment storage and maintenance sites and landings outside buffer strip.
6. Remove all limbs and tops from harvested trees from streams and nonforested wetlands.
7. Equipment use in a buffer strip should be avoided whenever possible. Equipment should not be operated within the buffer when soils are saturated. To avoid negative impact on forest growth within the buffer area, care must be taken not to interrupt the natural drainage of the soils.
8. Stabilize immediately all roads, cuts and fills in the buffer strip by using appropriate seeding and mulching mixtures.
(See Appendix A, and Chapter 5, A.3., and B.1., 2. & 3)
9. Energy dissipaters should be installed at culvert outlets or discharge points into or within the buffer strip.
10. Drainage structures such as ditches, culverts, retention areas, water bars, and broad-based dips should be used on truck and skid roads prior to their entrance to a buffer strip to intercept and properly discharge runoff.

BUFFER STRIP WIDTHS

SLOPE OF LAND ABOVE WATER BODY OR STREAM (%)	MINIMUM WIDTH OF STRIP (FEET)
0-10	100
10-20	115
20-30	135
30-40	155
40-50	175
50 +	Activity may not be advisable due to erosion potential. Extreme care must be taken to prevent movement of soil

Table 1. Buffer Strip Widths.

CHAPTER 2. Forest Land Roads and Trails – Considerations with Respect to Water Quality

Forest land roads and trails provide access for nearly all human uses of the forest and are necessary for the landowner to accomplish management objectives and stewardship of the land. A comprehensive management plan must include measures to control the potential negative impact on the quality of water on and emanating from forest land.

The considerations and specifications which follow apply to all forest land where management objectives require access roads, haul roads, logging trails, skid trails, log landing, and stream crossings. The construction, maintenance, and where appropriate, the retirement of all the components of a road system are described in detail below.

(See Table 5, and Chapter 5, A. - G.)

A. ROAD PLANNING

Every road system should be planned and developed as if it will be permanent. Initially, many roads are considered to be temporary, but often these temporary roads are used again and again. Therefore, the entire road system should be designed before any road construction begins. This process may seem to take more time, but the road system will be more efficient, less costly, and easier to maintain, and ensure minimum negative impact on water quality.

1. Reconnaissance

Before beginning reconnaissance of the forest area in preparation for road system development, locate the area on either an aerial photograph or a U.S. Geological Survey *(USGS) topographic map. Study the area, noting the lay of the land. Pay particular attention to steep slopes, flat areas, streams, spring seeps, boulders, rock outcrops, and other potential obstacles. Roads built on south-facing slopes tend to stay drier than those on north-facing slopes. Be sure to look at these problem areas during the walk-through of the area.

Most of the counties in Michigan have completed soil surveys. Contact the county Soil Conservation District, Natural Resource Conservation Service, or the MSU Extension for information about obtaining or using the soil survey. (See Chapter 5, B. 1. and C.) The soil survey often contains aerial photographs of the entire county. Locate the treatment area on the photograph and determine the soil series within the boundaries of the proposed treatment area. Soil series are described in the survey.

This description covers the nature and limitations of the soils, erosion hazard, rock outcrops, construction and engineering properties of each soil series.

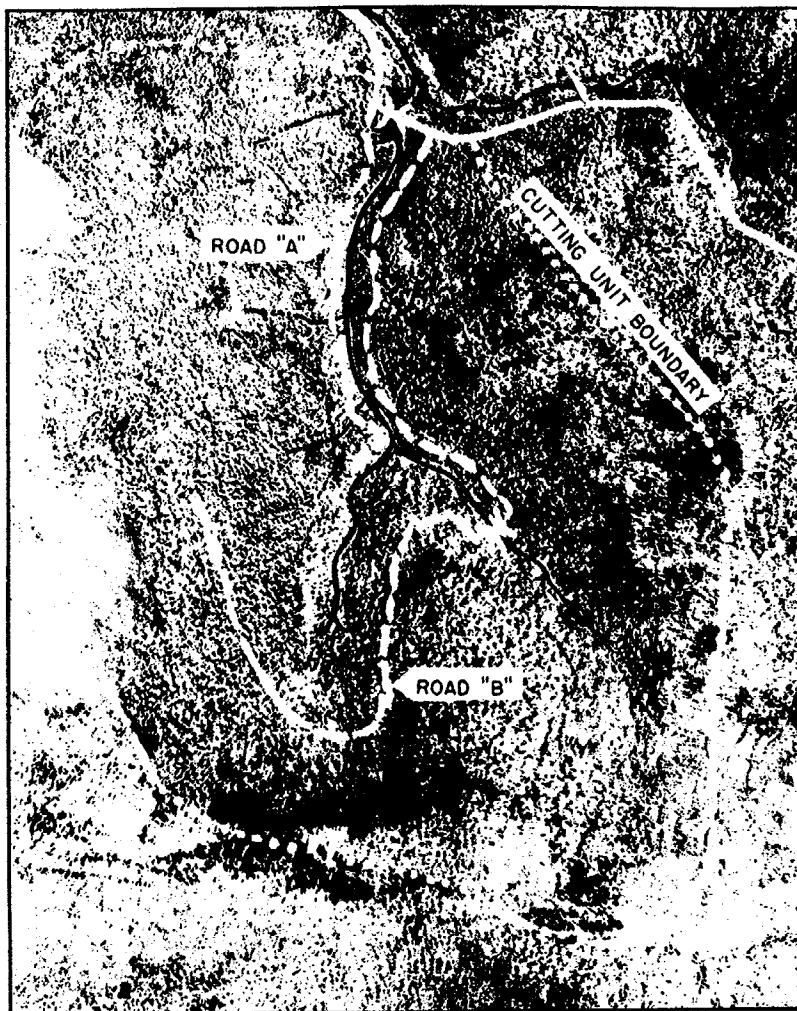


Figure 2. Aerial Photo (same area as Figure 3.)

Road reconnaissance consists of looking at the property with a road plan in mind and developing an idea of where roads should or should not be built. Consider the following points during road reconnaissance:

- Terminal points – where is the system going to start and end? Where is the best access from public roads? Where are the landings going to be?
- Grades – Roads designed with a slope of 10 percent or less are usually the easiest to maintain.
- Topography – Roads on moderate side hills are easiest to build and drain.

- Obstacles – Note springs, seeps, wetlands, poor drainage areas, ledges, and rocky areas. Design the road system to go around them.
- Soils – Note soil texture, drainage class, and slope position. Some soils are poorly drained or seasonally wet and are difficult to log.
- Distance from streams – Buffer areas are important because they can trap sediment.
- Stream crossings – Cross at a 90 degree angle and approach the stream at as gentle a slope as possible. Keep the number of crossings to a minimum.

(See Table 5, and Chapter 5, A.1., 2., 3., 4., B.3.)

- Old roads – It is often possible to use existing roads and thereby lessen soil disturbance. However, to avoid problems, carefully evaluate the road as to its suitability for upgrading.
- Size and duration of a timber sale and the anticipated season of harvest.
- The location and potential impact on flood plains and wetlands.

(See Table 5 and Chapter 5, A.1.b. and k.)

2. Factors Limiting Design

Since roads, even temporary ones, become permanent landscape features in the forest, the landowner's objectives should be considered in the design process. Is access to certain areas required? Should certain areas be avoided? Have special management areas been identified and are permit requirements known? These factors should be discussed at length with the landowner.

Property lines must be considered since they may restrict the use of the best access location. It may be necessary to negotiate or purchase right-of-ways from adjacent property owners or to relocate the access.

Certain site characteristics may cause problems with road design and construction. Topography is a major concern since the land may be too steep or too flat. While evaluating the site, consider the stream-flow patterns within a watershed drainage area. Working with this pattern often helps to minimize the number of stream crossings. Also consider the nature of the soils in the treatment area.

3. Locating The Road

Before returning to the harvest area, sketch the tentative location of the roads, landings, major skid trails, and the approximate buffer strips on the plan map, using the USGS topographical map as a reference. It is a good idea to enlarge the section of the USGS map that pertains to the timber sale and to use that enlargement as the plan map.

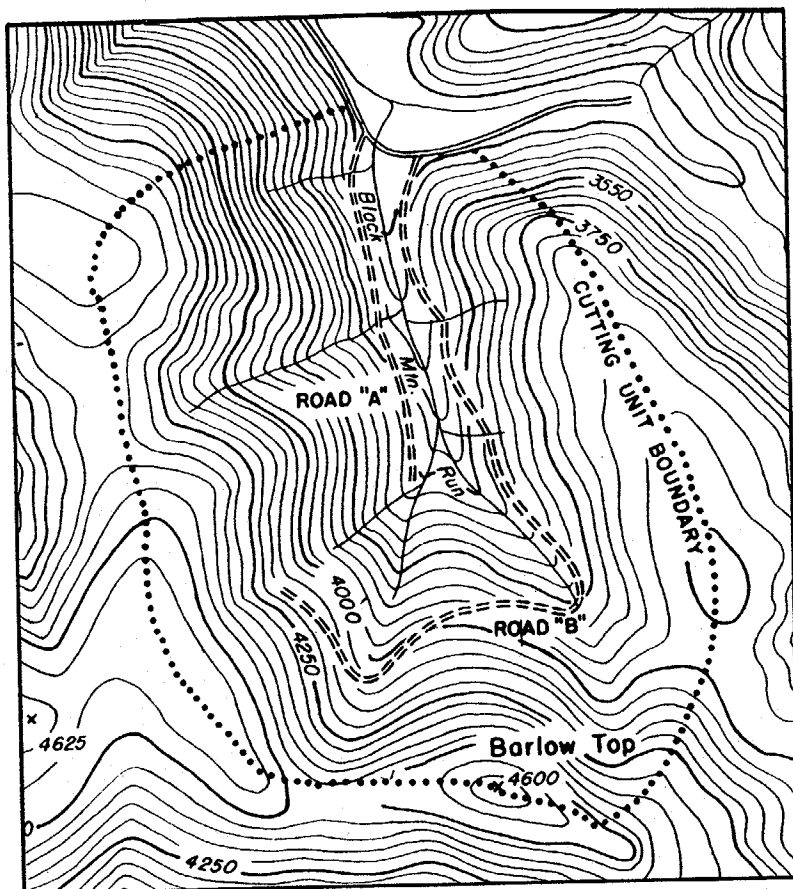


Figure 3. Topographic Map (Same area as Fig. 2)

Planning on paper helps to pinpoint potential problems, to develop alternative routes, and to consider what control measures are necessary. Having the buffer strips identified early will help to prevent locating roads or major skid trails in those sensitive areas.

Where possible, construct roads on side hills for good cross-drainage, but avoid seeps, springs, and swampy areas. If a stream, spring, or seep cannot be avoided, plan to use a proper water control structure.

The landowner and the person planning the road system should walk the proposed route of the road system and decide on matters affecting the owner's objectives and construction costs.

A road grade of 2 to 10 percent is desirable. A hand level should be used to avoid problem areas and maintain the desired grade of the road. Grade and slope are expressed as the amount of vertical rise divided by the horizontal distance traveled, multiplied by 100. Check the grade

frequently with the hand level. A single stretch that is too steep or a flat area that will not drain will restrict the use of the entire system. A minimum 2 percent slope is necessary to maintain positive drainage.

Long steep grades encourage the buildup of drainage water and increase erosion potential unless adequate drainage structures are installed. Roads with no grade also present a problem because they are difficult, if not impossible, to drain.

Where absolutely necessary, grades of 15 to 20 percent may be used for short distances, i.e., less than 300 feet. Where a steep grade is necessary, at least 300 feet of road above and below should be less than 10 percent grade to reduce the amount and velocity of water on the steep area. On those portions of the road with such steep grades, special surfacing of the road way may be necessary to avoid erosion.

Designing a road system to meet the minimum and maximum suggested slopes takes planning. Start by obtaining a USGS topographic map for the proposed treatment area. These maps show contour lines, which connect all points of equal elevation.

From the map, determine the control points. These are the high and low points for a road segment – the sections of the road where slope direction does not change. Decide on an average slope for the segment of road, remembering to stay between 2 and 10 percent.

Return to the field and flag a rough grade line along the proposed location. Obstacles such as rock outcrops and wet areas that are not visible on maps and photographs may require changes in the proposed locations. Since keeping forest-access roads within acceptable grade limits can be a problem, major changes in the proposed road location may be necessary. Rerun grade lines until a satisfactory road location is determined. Then determine the number of culverts, bridges, and other necessary measures. For information on sizing, consult the water and erosion control structures guidelines.

4. Buffer Strips

Where roads will be located near perennial and intermittent streams, ponds, lakes, and wetlands allow for an adequate buffer strip. The width of the buffer strip depends on the slope between the road and the stream. Use Table 1, to determine the minimum widths. Keep soil disturbance in the buffer strip to a minimum. When an area is disturbed and soil exposed and is likely to cause erosion and sedimentation, additional stabilization measures may be necessary.

5. Soils

Some soils are excellent for road construction, while others are not. Yet the importance of soil type in the harvest area is not always recognized in designing road systems.

General soils information is available at local Soil Conservation District offices. The soil survey contains specific information on soil types and soil features, such as drainage and suitability for road base, that may affect road location and construction.

(See Chapter 5, B.1.)

Soil drainage is one of the most significant considerations in road construction. Soils classified as somewhat poorly drained often cause problems because they may not support the weight of logging equipment during periods of soil saturation. Poorly drained soils always cause problems during these periods. These problems hold true for both new roads during construction and existing roads. These problems most often occur in the period October through April, especially during rainy periods or when rising temperatures allow a frozen road surface to thaw.

Do not interpret surface features such as stones as indicators of soil drainage. Several imperfectly drained soils in Michigan appear from surface features to be well-drained when in fact they are not. The extent and types of soils encountered in forest areas can be highly variable. The planner must recognize the capabilities of a soil and be prepared to adjust the road design during construction to avoid problem areas, especially near streams, wetlands, and flood plains.

(See Table 5, and Chapter 5, A.1., 2., 3., 4., and 5., B.1., C.-G.)

6. Road Drainage

The first priority for constructing a road system is to keep the road surface as free of water as possible. Surface water running over exposed soil builds up momentum as the slope and distance increase. The running water picks up soil particles then transports them down hill, causing soil erosion. Road drainage is the single most important factor in keeping the road passable and in minimizing erosion and sedimentation. Various structures for water control and erosion control are discussed in "Haul Roads" and "Skid Trails" below.

7. Winter Roads

Winter roads and trails provide access during frozen ground conditions for timber harvesting and other timber management activities. Properly constructed winter roads are recognized as an important component of forest management. To minimize the impacts to water quality during spring breakup, the following recommendations should be included in the design of winter roads:

- a. Consider using culverts or bridges to cross definite drainages where winter roads are to be used for several years.
- b. Construct water crossings on winter roads using proper drainage structures to minimize sediment load from the area.

(See Table 5 and Chapter 5, A.1.e. and j.)

- c. Consider the placement of native materials, such as log corduroy or ice bridge, across the waterway when practical alternatives to frozen water crossings do not exist. But, avoid the use of mineral soil as fill over the logs or directly in the crossing because such material will eventually be washed downstream.
- d. Construct winter road crossings on level terrain where practical. Where adjacent ground slope generally exceeds 3%, avoid placing organic materials in the crossing.
- e. Upon completion of winter road use, any materials placed in a drainage way, must be removed.

8. Road Closure and Retirement

Whenever it serves the forest landowner's management objectives, access roads should be closed to vehicular traffic. This can be done on a seasonal or semi-permanent basis. The reduction of traffic and associated maintenance work will mean a significant reduction in cost, as well as reduction in the source of erosion and sedimentation impacts on the water resource. When a several year period between major treatment activities is anticipated, roads should be retired, exposed soil areas stabilized and re-vegetated. Periodic inspection is necessary to insure erosion prevention is maintained. The following actions are recommended to retire a section of road:

- a. Smooth and shape all road and landing surfaces to original design standards.
- b. When culverts are removed, replace them with water bars, or ditches. If culverts are covered by more than 2 feet of fill and inlets and outlets are effectively stabilized, leaving them in place is often better and less costly than removing them. Culverts left in place require continued maintenance.
- c. Remove all temporary stream crossings.
- d. Seed and mulch critical areas near streams or where erodible soils or slippage areas exist. Information on plant materials and types of seeding is available from Soil Conservation Districts.
(See Table 5 and Chapter 5, A.3., B.1. and 2.)
(See Appendix A)
- e. Whenever stabilization is required, silt fences should be placed to trap any sediment that may be eroded during the unstable period.
- f. Consider employing alternative methods of soil stabilization, such as brush mulching, stone surfacing, or water bars.

B. HAUL ROADS

Haul roads are that part of a forest land road system, either temporary or permanent, which are designed and maintained for the transportation of timber products and access for protection activities and recreation activities. They are usually minimum

standard roads, i.e., single lane with turnouts, surfaced with locally available materials. Commercially processed gravel is used in critical erosion areas. Properly laid out, constructed and maintained roads provide safe operations over longer periods at desirable vehicle speed. They reduce operating and maintenance costs and will maintain the water quality standards.

1. Specifications for Construction:

- a. Roads should follow contour as much as possible with grades between 2% and 10%. Steeper gradients, not to exceed 15%, are permissible for distances up to 300 feet. By breaking or changing grade frequently, less erosion problems will be encountered than on long, straight continuous gradients.

On soils with severe erosion hazard, grade should be 8% or less. Grades up to 12% are acceptable, if less than 150 feet long. Water diversion by cross drainage (interception of surface water on road, up slope from the top of these steep slopes) is often needed to keep excess water off the steeper grades.

(See *Water and Erosion Control Structures*.)

- b. All watercourses will be crossed as close to a right angle to the stream as possible. Structures will be sized so as not to impede stream flow in keeping with good drainage practices.

(See *Table 5 and Chapter 5, A.1.*)

- c. Road gradients approaching water crossings should be reduced to disperse surface water at least 50 feet from the watercourse, so it will not reach the watercourse. Roads should be located (with the exception of stream crossings) a minimum distance of 50 feet from any intermittent or permanent watercourse. Distance is measured to the edge of soil disturbance, in case of fills, to the bottom of the fill slope. Fording should be avoided if at all possible, as water quality will be affected. Fords may be used only when culverts or bridges are not feasible, and when stream banks are stable and bottoms hard. Stabilize stream bank approach with rock and other material.

- d. Outslope the entire width of the road where road gradient will permit. Inslope the road toward the bank as a safety precaution on sharp turns, road gradients of 15% or greater, and on clay and/or slippery soils.

(See *Broad-Based Dip or Culvert specifications*.)

- e. Where roads are insloped, it is recommended that cross drain interception of surface water be placed 25 feet up-grade of any short stretches of road where gradients exceed 10%.

- f. Avoid locating roads on level ground, along ravine bottoms or on a wet flood plain soils where drainage away from the roadway is difficult to establish.

- g. On truck roads that intersect main highways, gravel or other aggregate can be used for about the last 200 feet to keep mud and dust off the highway.
- h. Provide a minimum essential width of 12 to 14 feet for a single track road. Increase width as necessary at curves and turnouts.
- i. Road-bank cuts should be sloped and seeded to prevent erosion.
- j. Ensure good road drainage with properly constructed and spaced turnouts, broadbased dips, culverts and bridges. Turnouts will be constructed so water will be dispersed and will not cut channels across buffer zones.
- k. Install riprap or rock at the outlets of culverts to absorb force and spread waters.

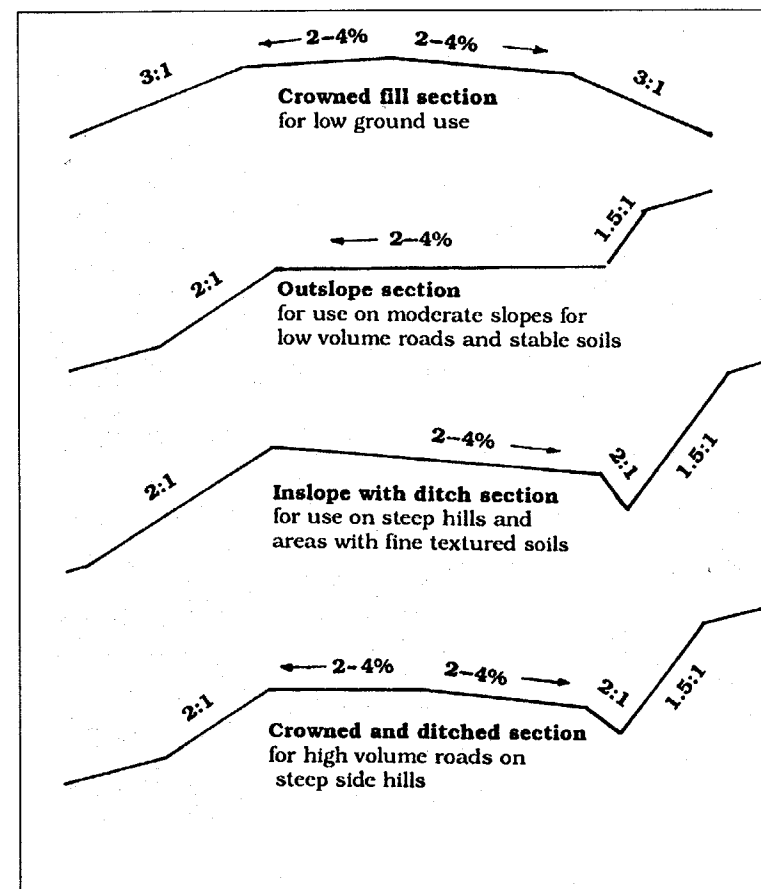


Figure 4. Road Cross Sections

- l. Cut trees along side the road where daylight is necessary to ensure drying of the road.
- m. Cleared materials can be used for brush barriers or check dams along fill areas or other sensitive areas.

2. Water and Erosion Control Structures

The control of overland flow of water on constructed roadways is accomplished by the placement and use of various devices and structures.

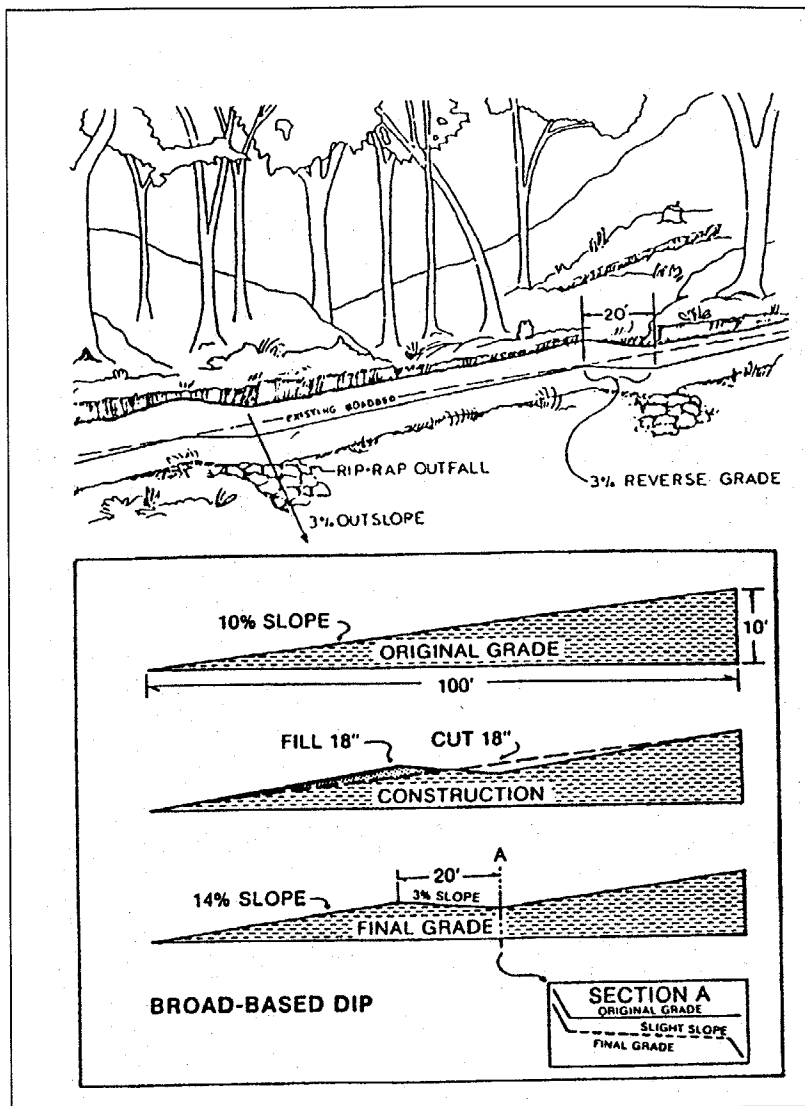


Figure 5. Broad-Based Dip

It is always more effective to control runoff and erosion, than it is to control the sediment generated from the erosion. The purposes and specifications for each control structure are as follows.

- a. Broad-Based Dip – Provides cross drainage on haul roads to prevent buildup of excessive surface runoff and subsequent erosion. Broad-based dips can be used on roads and heavily used skid trails having a gradient of 12% or less. They are not used for cross draining spring seeps, intermittent or permanent streams. This practice may be substituted for other surface water cross drain practices such as pipe or box culverts. An inherent problem in construction of a broad-based dip is to recognize that this roadbed consists of two planes rather than one unbroken plane. One plane is the 15 to 20 foot reverse grade toward the uphill grade and outlet. The second plane is the long grade from the top of a hump or start of a down grade and ends at the outlet of the dip. Neither the dip nor the hump should have a sharp angular break but be rounded, allowing a smooth flow of traffic. Only the dip itself should be outsloped since the dip provides sufficient break in grade to turn the water.

Specification For Broad-Based Dip

1. Installation takes place following basic roadbed construction.
2. A 20-foot long, 3% reverse grade is constructed into the existing roadbed by cutting from upgrade of the dip location and using cut material to build up the mound for the reverse grade.
3. Spacing of broad-based dips will be as shown in the following table:

SPACING FOR BROAD-BASED DIPS	
Road Grade (Percent)	Spacing Between Dips (Feet)
2	300
3	235
4	200
5	180
6	165
7	155
8	150
9	145
10	140
12	100

Table 2. Spacing for Broad-Based Dips

4. Cross drain must slope to a controlled discharge at no more than a 30% slope.
5. An energy dissipater should be installed at the outfall of the dip to dissipate water velocity assuring no erosion of cast fill.
6. The dip and reverse grade section may require a surface of at least 3" of crushed stone, in some soils, to avoid rutting of the road surface.

- b. Water Bars – A temporary shallow trench constructed across a road or skid trail. It may be a pole reinforced on sandy soil. The water bar intercepts and diverts side ditch and surface runoff from road or skid trails to minimize erosion and provide conditions suitable for natural or artificial re-vegetation. Since it is a temporary measure, it is used where no vehicular traffic is expected, such as old trails and retired haul roads.

SPACING FOR WATER BARS	
Road Grade (Percent)	Spacing Between Dips (Feet)
2	250
5	135
10	80
15	60
20	45
30	35

Table 3. Spacing for Water Bars

1. Proper spacing between water bars can be determined from the above table.
2. Installation should be at an angle of 30 or more degrees down slope or to turn surface water off the road or trail.
3. A shallow trench, 12" to 18" below the surface of the road or trail would extend beyond both sides.
4. The uphill end of the bar extends beyond the side ditch line of the road and ties into the bank to fully intercept any ditch flows.
5. The outflow end of the bar is to be fully open and extended far enough beyond the edge of the road or trail to safely disperse runoff water onto the undisturbed forest floor.
6. On sandy soils a 5" to 8" pole is placed in the trench and pegged and filled with soil on the down slope side.

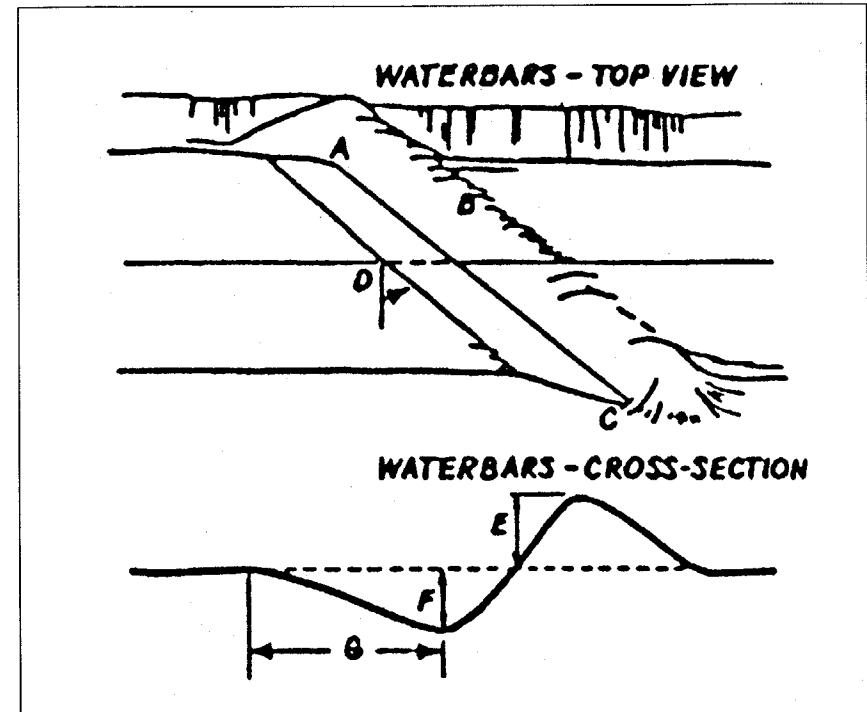


Figure 6. Water Bar

Water bar construction for forest roads with little or no traffic. Specifications are average and should be adjusted to conditions.

- A- Bank tie-in point, cut 6" to one foot into the roadbed.
- B- Cross drain berm height 1 to 2 feet above the roadbed.
- C- Drain outlet cut 12" to 18" into roadbed.
- D- Angle drain 30 to 45 degrees downgrade with road centerline.
- E- Up to 2 feet in height.
- F- Depth to 18 inches.
- G- 3 to 4 feet.

Always place an energy dissipater or weather-spreaders at or below drain outlet.

c. Pipe Culverts

Corrugated metal pipe or other suitable material is placed under haul road or major skid road to transmit side ditch storm runoff, seeps and small intermittent or live watercourse flows. Culverts can be used for any size operation where cross drainage of storm water or diversion of ditch

flow is needed for haul roads or major skid roads. In many cases, where a necessary drainage for temporary operations is considered, it is often better to develop a stable permanent installation than a poorly serviceable temporary structure which disturbs the intermittent water course. (See Table 5 and Chapter 5, A.1.b., c., and e.)

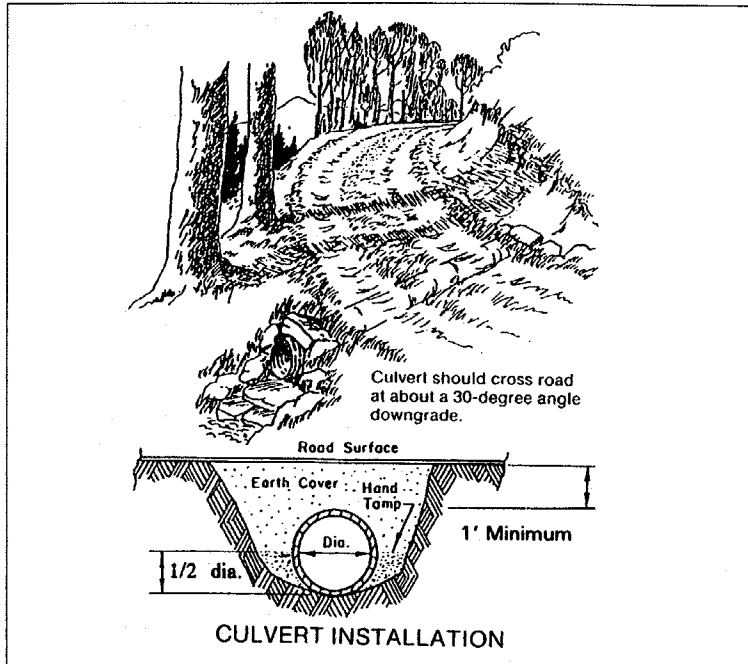


Figure 7. Pipe Culvert

Specifications for streams crossing culverts are as follows:

1. Pipe length should be long enough so both ends extend 2 feet beyond side slope.
2. Fill material should be a minimum of one foot over the pipe, or at a depth specified by the culvert manufacturer.
3. The pipe diameter is matched to the amount of water that must pass through to expected high water flows. One example of a field expedient method of estimating the appropriate size of a culvert for a particular stream crossing is the Hasty Method. Figure 8 illustrates the Hasty Method for calculating the pipe diameter, from measurements taken in the field. This method of calculating culvert size includes a safety factor of 100%.

Table 4. shows the conversion of the calculated end area in square feet to the equivalent diameter of the pipe.

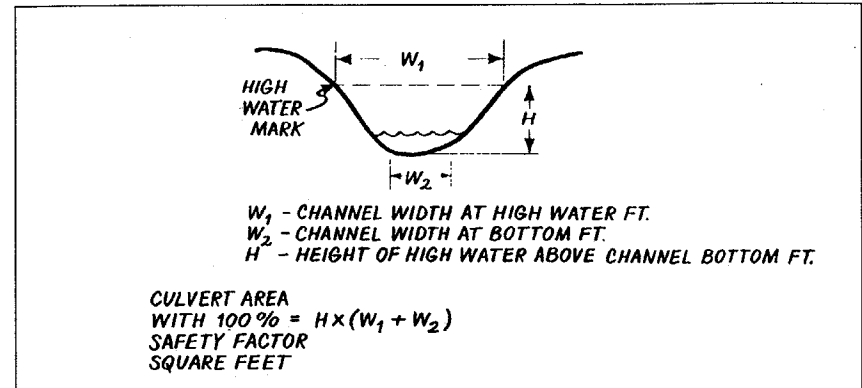


Figure 8. Hasty Method for Determining Culvert Size

The following is a sample calculation using the Hasty Method.

Example: At the site where a culvert is to be installed, the following three measurements are taken: channel width at the High Water Mark (W_1) (also called the Ordinary or Normal High Watermark) is 3 feet; channel width at the bottom (W_2) is 2 feet; and the height of the High Watermark above channel bottom (H) is 3 feet.

The formula $H \times (W_1 + W_2)$ = culvert end area in square feet; $3 \times (3+2) = 15$ sq. ft. Referring to Table 4., an end area of 15 square feet indicates a culvert diameter of 54 inches.

CULVERT END AREA & DIAMETER	
End Area (Square Feet)	Diameter (Inches)
1.80	18
3.10	24
4.90	30
7.10	36
9.60	42
12.60	48
15.90	54
19.60	60
23.80	66
28.30	72
33.20	78
38.50	84
44.20	90

Table 4. Culvert End Area & Diameter

4. Pipe slope should be the same as the stream bed slope with pipe alignment the same as stream course or thread of stream.

Specifications for roadway cross drainage culverts are as follows:

1. Pipe length should be long enough so both ends extend 1 foot beyond side slope.
2. Pipe slope should be 2% to 4% grade to reduce clogging.
3. Pipe alignment should be angled downgrade 30° to 45°. Pipe diameter should match the cross sectional area of the side ditch.
4. Energy dissipaters and erosion protection is provided for outflows of culverts to minimize erosion down slope or downstream of the outfall; it may also be needed on the upstream end of culverts on flowing streams. This protection can be in the form of riprap, plastic filter cloth or large stone.

d. Open Top Culverts

Open top culverts, also called "box culverts", collect and direct road surface storm runoff and up slope side ditch flows across road without eroding drainage system or road surfaces. This is a drainage structure for on-going operations and not permanent. It can be used for cross drainage on truck haul roads on smaller operations as a substitute for pipe culvert, however, it fills in readily and requires frequent maintenance.

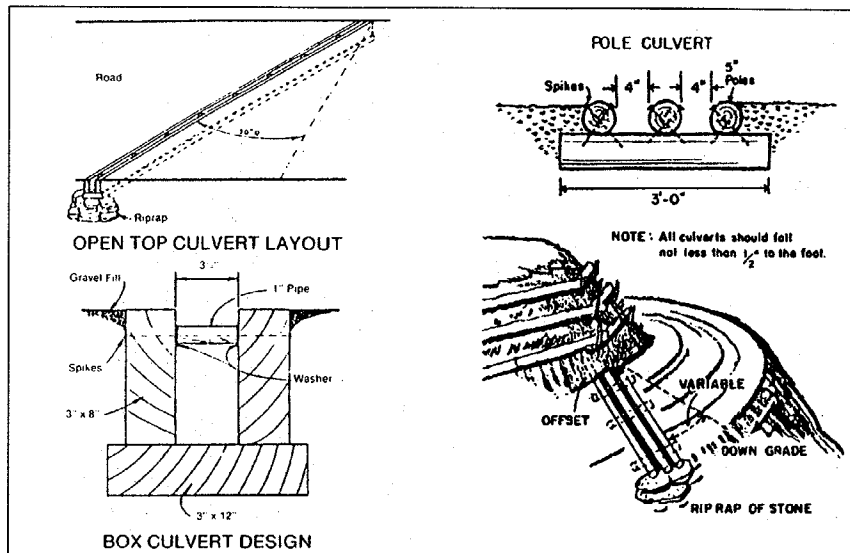


Figure 9. Open Top Culverts

This practice should not be used for handling intermittent or permanent streams or skid trail cross drainage.

Specifications for installation and use are as follows:

1. Box culvert is to be installed flush or just below road surface and angled 30° to 45° downgrade.
2. Upper end will be at grade with side ditch and extend into toe of up slope bank.
3. Outfall will extend beyond the road surface with adequate riprap or other material to dissipate water velocity to assure no erosion of fill material.
4. Spacing is the same as that for broad-based dips.
5. Clean-out maintenance must be carried out to remove sediments, gravel and logging debris to allow normal function of structure at all times. Daily clean-out may be necessary during wet weather.

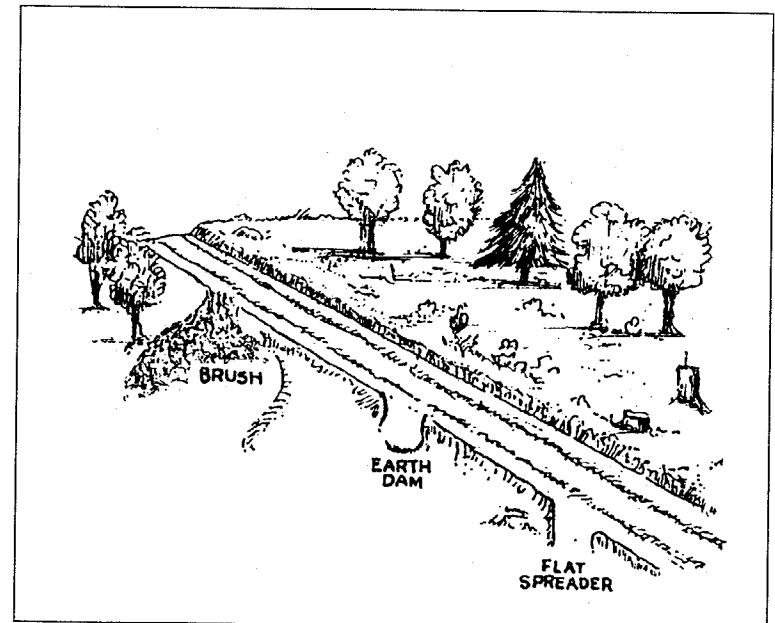


Figure 10. Diversion Ditch

e. Diversion Ditches

A diversion ditch, sometimes called "water turnout", serves to divert water away from the roadway and the side ditches. It is typically used where haul roads cross streams to ensure that water flowing off the road surface

and in the side ditches will be diverted into the buffer strip and not flow directly into the stream. When a road must be placed where there is little or no slope, a diversion ditch into a collecting basin may be the only way to move water away from the base of the road bed.

Specifications for diversion ditches are:

1. The diversion ditch must intersect the side ditch line at the same depth and be outsloped 1° to 3°.
2. On sloping roads, the diversion ditch should be 30° to 45° down slope.
3. They should be spaced to allow the roadbed to dry out and reduce the volume and velocity of road side ditch waters.
4. Runoff water is to be spread, retained, or filtered at the outlet of the ditch.

f. Sediment Control

Sediment can be controlled, on a temporary basis, by devices or structures which interrupt the flow of waterborne sediment and cause the sediment to be deposited, trapped or filtered out before the water passes into the adjacent body of water. All sediment control devices must be routinely maintained, cleaned or replaced, until a stable condition is reached and erosion is no longer possible.

(See Table 5 and Chapter 5, A.1.c. e. and j.)

Descriptions of several devices are:

Brush barriers – The use of slash materials at the toe slope of road and outlets of culverts, diversion ditches, water bars or dips.

Burlap or jute material – Dams made of sheet material to entrap sediment and release water through fabrics.

Cribs – A square or rectangular structure built of natural materials (logs) and located below an elevated culvert pipe outlet. The crib is filled with stone or brush to absorb and dissipate the force of falling water.

Silt fence – A plastic sheeting material with the capability of retaining most suspended materials and releasing waters through the fabric. Not recommended for use in a permanent flowing stream.

Grass or vegetation slough way – A sediment trap of heavy grass sod and vegetation into which the water is directed by ditching.

Hay or straw bales – Bales are placed end to end to form a small check dam, at drainage or pipe outlet. Bales are secured in place with stakes. Not recommended for use in a permanent flowing stream.

Plastic sheets – Used at culvert outlet to spread runoff waters.

Ripraps – Brush, slab wood, or rock materials used to absorb or dissipate the forces of concentrated runoff waters.

Sediment trap (water sump) – Collects water and traps sediment as water infiltrates the ground (light, sandy soils).

Trash dams – Log dams within small gullies to slow the flow of water and trap sediments.

3. Maintenance of Forest Roads

A properly designed and constructed forest road must be well maintained or the water quality protection structures may quickly degrade. To ensure negative impacts remain minimal, maintenance must continue throughout the life of the road.

The following specifications apply to active roads:

- a. Inspect the road at regular intervals to detect problems and schedule corrective work.
- b. Keep roadway and water control structures free of windfalls, logging debris and other obstructions.
- c. Restrict traffic on roads during wet periods and spring breakup.
- d. Ensure the free flow of water in their road drainage system, especially during logging operations.

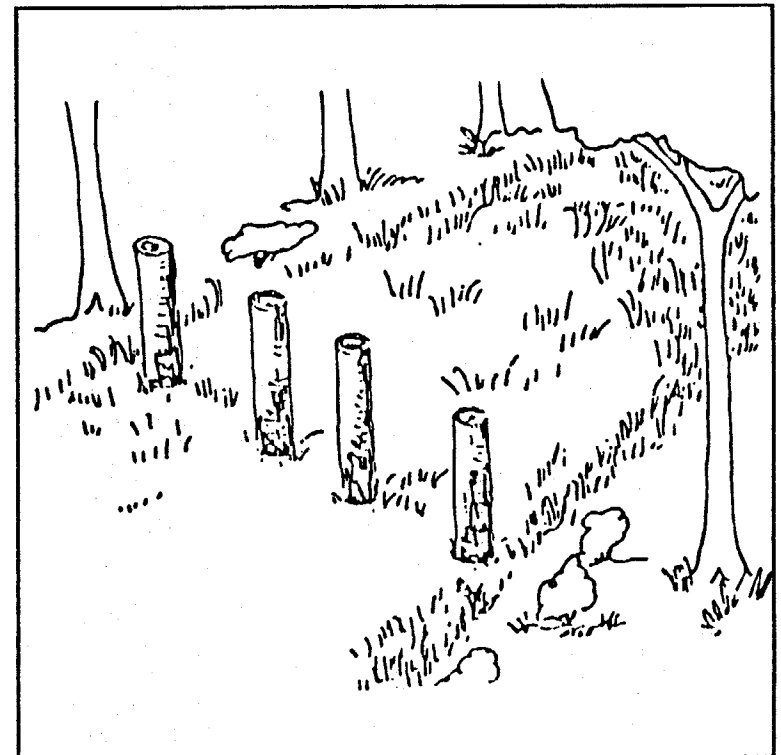


Figure 11. Stabilization of Retired Road

- e. Upon completion of any treatment operation, grade the road surface to reshape it so that it sheds water as originally designed.
- f. Fill in ruts and holes as they develop.

For roads which are inactive or have been closed and retired, the following specifications apply:

- a. Maintain a "Road Closed" structure at the beginning of the road.
- b. Place and maintain water bars where slope of road requires and keep drainage structures working and stabilized. (Table 3.)
- c. Ensure the road surface remains stabilized by vegetative cover.
(See Table 5 and Chapter 5, A.3., and B.1. and 2.)
(See Appendix A.)

C. SKID TRAILS AND LOG LANDINGS

The building and use of landings and skid trails has a most notable and dramatic effect on the condition of forest lands and forest floor and vegetation. Although the impact is usually temporary and of short duration, erosion risk is high while the disturbance is ongoing. Negative impacts on water quality can be avoided by ensuring the following specification are accomplished.

1. A skid trail is a single lane trail or road used for the skidding or transporting of timber products from the stump to a landing. After the location of log landings is established and road lay-out is complete, the skid trail network is laid out. The major considerations for skid trail placement are; minimize damage to residual trees, minimize erosion and sedimentation and be an economical method for moving the timber products.

For some forest conditions, such as very steep slopes (over 15%), unstable soil conditions, and critical buffer areas, cable skidding may be the only method of avoiding erosion and sedimentation of adjacent streams.

The following are considerations for the location and use of skid trails:

- a. Gradients should not be steeper than 15% with exception of short, steep segment which do not exceed 20%.
- b. Skid trails will be located outside the stream side buffer strip.
- c. Any skid trail necessitating the crossing of a flowing stream will require a bridge or a culvert of acceptable design. Logs should not be skidded through identifiable stream channel.
- d. Approaches to water crossing should be as near to right angles (90 degrees) to the stream direction as possible.
- e. Climb up slope on a slant or zig-zag pattern breaking the grade and avoiding long steep grades on the trail. This will reduce the potential for gully making.
- f. Look for alternative skidding using several different skid trails instead of only one primary trail.

- g. Skidding operations should avoid gullies, seeps and other permanently wet areas.
- h. Upon completion of skidding operations, the areas subject to erosion should be stabilized quickly. The first need is drainage of skid roads and exposed skid trails by establishing water bars at minimum intervals. (See Table 3.)

Water bars should be installed at a near 30 degrees angle down slope, with ends open to prevent water accumulation behind them. A permanent vegetative cover should be established upon exposed roads, trails, and landings. Scattered logging slash which covers the trail may supplement water bars and seedings.

(See Table 5 and Chapter 5, A.3. and B.1. and 2.)
(See Appendix A.)

2. Log landings are areas, located during pre-harvest planning, where timber products are assembled, and may be further processed before being loaded for transport from the forest area. The landing includes a portion of the haul road and the end of one or more skid trails. The area must be large enough to accommodate traffic and handling of timber materials and their temporary storage on the landing. Landings are often used for temporary storage of harvesting equipment and for fueling, daily maintenance and equipment repair.

The following specifications apply to log landings:

- a. Locate landings in advance of road construction.
- b. Locate landings outside the buffer strips.
- c. Landings and yards should have a slight slope to allow for drainage, and should be on well-drained soils which dry out quickly.
- d. Provide for adequate drainage on approach roads and trails so that surface water drainage does not enter landing area and cause mud holes.
- e. Provide diversion ditch around uphill side of landings where seepage and lateral flow of water is a problem.
- f. The servicing of equipment on site can be done in such a way that oil, fuel and other lubricants are drained into containers and properly disposed of in accordance with proper solid waste disposal. Garbage and trash will be removed and disposed of properly.
- g. Locate residue piles (sawdust, slabs, etc.) outside of wet weather drainages so that water from residue will not drain into adjacent streams or bodies of water.
- h. Re-vegetate landings immediately following completion of operations with appropriate seeding and mulching mixtures.

(See Table 5 and Chapter 5, A.3. and B.1. and 2.)
(See Appendix A)

Chapter 3. Site Preparation and Reforestation – Considerations with Respect to Water Quality

The long-term management of forest land includes a commitment to a sustainable perpetual forested landscape. It is necessary for management plans that include timber harvesting to also include consideration of site preparation work and regeneration efforts. Site preparation includes mechanical means, prescribed burning, and chemical treatments. Reforestation can occur naturally or be induced by mechanical means of seeding and planting.

For all forested land when timber products are harvested, the landowner should plan for regeneration of the stands by either natural or induced means. Site preparation refers to those methods necessary for the establishment of desired tree species, to control undesirable competing vegetation, the reduction of organic debris and logging residue and the reduction of wildfire risks.

Special attention should be given to avoid surface disturbances in areas which are subjected to periodic flooding, such as spring break up flooding.

A. MECHANICAL SITE PREPARATIONS

The following are minimum specifications for various mechanical means:

1. General Considerations:

- a. Use mechanical site preparations techniques that will cause the least disturbance to the site and still achieve the owner's objective.
- b. Provide adequate buffer strips.
- c. To minimize erosive impacts, mechanical treatment should be oriented along the contours of the site.
- d. Evaluate site for saturated soil conditions. Avoid operations during periods of saturated soil conditions that may cause rutting or accelerated soil erosion, and remove impediments to beneficial soil drainage.

2. Shearing and Raking:

- a. Avoid dumping or concentrating residues from shearing and raking operations in flood plains or wetland areas. These residues should be deposited in stable areas where they neither interfere with drainage and not cause erosion.
(See Table 5 and Chapter 5, A.1., b., and k.)
- b. Locate windrows and piles to minimize interference with natural drainage patterns.
- c. Locate windrows outside the buffer strips.
- d. Give preference to locating windrows along contours to mitigate the effects of overland flow.
- e. Minimize incorporation of soil material into windrows and piles. Two examples of preferred practices would be (1) shearing and raking under frozen soil conditions, and (2) light raking which would only remove slash.

- f. Avoid shearing and raking operations on organic soils except under frozen soil conditions.

3. Disking (and other scarification treatments, such as chain drags and land breakers):

- a. Should be limited to slopes of less than 10%, for all highly erodible soils.
- b. Follows the land contours with proper consideration given to equipment operator safety.
- c. Has the advantage of reducing soil compaction and incorporating organic matter.

4. Patch and Row Scarification:

- a. Use patch or row scarification as the preferred mechanical site preparation method for artificial regeneration where terrain or soil type necessitate minimum soil disturbance.
- b. Follow the contours of the land, as long as operator safety is maintained. Slopes greater than 18% are hazardous.

5. Drum Chopping:

- a. Limited soil exposure occurs as residual trees and debris are knocked down.
- b. Maximum benefit comes from drum chopping up and down the slope so that blade depressions are on the contour, reducing the occurrence of channeled surface flow.

B. PRESCRIBED BURNING

Using fire under controlled conditions can have the benefits or reduction of slash, reduce or eliminate the encroachment of undesired and competing vegetation, as well as creating a seed bed or surface condition for natural or artificial regeneration of desired tree species. To achieve the desirable conditions, prescribed use of fire must be carefully planned and executed under strict weather and fuel conditions.

(See Table 5 and Chapter 5, A.3.)

The following considerations must be applied:

1. Is burning necessarily safer, cheaper or more effective and practical than other means of site preparation?
2. Secure necessary burning permit and burn only with trained crews under prescribed conditions of humidity, temperature and wind.
3. Firelines must be planned and constructed prior to burning to confine burning to the prescribed area.
4. Construct water bars on fire breaks on hilly or steep terrain where the slope is greater than 2%. See specification for construction of Water Bars.

5. Adequate buffer strip must exist if the burn is adjacent to an intermittent or perennial water body.
6. After a burn is accomplished, any erosion control structures associated with the area and fire lines must be maintained. Any spots of potentially heavy erodible soil should be seeded and revegetated as soon as practical.

C. CHEMICAL TREATMENT (Pesticides)

Use of chemicals to control vegetation (herbicide), insects (insecticide), small animals (rodenticide), and molds and fungus (fungicides) can be an efficient and effective means of site preparation. Herbicides have advantage over mechanical means because there is no soil disturbance and can be used where steep slope prevents use of machinery. Herbicides can also be used in an existing stand for preharvest treatment. Insecticides, rodenticide and fungicides can be applied to seeds or seedlings before or during planting to increase planting effectiveness (survival). However, water quality impacts must be a consideration in all use of chemicals to prevent their reaching ground water and surface water bodies.

Potential water quality impact varies widely from one chemical to another and depends primarily on (1) the chemical's mobility, (2) its persistence, (3) the accuracy of its placement and (4) orientation of site to streams. Water quality can be protected by knowledge of the chemical being used and adherence to the manufacturer's specification and directions. The label contains information regarding the safety of the applicator, species for which the chemical is registered, the pesticide rate or concentration, appropriate weather conditions for application environmental impact and proper container disposal. Material Safety Data Sheets provide toxicological data and are available from a chemical's manufacturer. For further guidance on use of pesticides, see Chapter 4, A.

D. REFORESTATION

All of the above described means of site preparations are designed to meet the objective of maintaining a healthy and vigorous forest on the landscape. Regeneration of desired tree species and associated plant communities occurs through natural process and by seeding and tree planting.

(See Table 5 and Chapter 5, A.1. and 3., and B.1., 2., and 3., C.F. and G.)

Chapter 4. Forest Protection – Considerations with Respect to Water Quality

Forest protection includes those management functions and activities through which the forest landowner demonstrates a sense of stewardship and a commitment to the perpetuation of healthy and vigorous forest resources.

Forest lands contain a great variety of natural resource values and ecological systems, including surface and ground water and aquatic habitats, all of which must be protected.

This chapter focuses on three areas of potential major threat to water quality. Pesticides can be used to control or eliminate disease, undesired insects, animals and vegetation. The control and suppression of wildfire and reclamation of burned areas can be crucial to meeting management objectives. Where forest land is associated with agriculture, horticulture and animal husbandry, the control and physical exclusion of livestock from the forest can be a critical protection concern.

A description and specifications related to pesticide use, control of wildfire and livestock exclusion follow.

A. USE OF PESTICIDES

Use of chemicals to destroy or control forest pests and to eliminate vegetative competition with desired tree species may be the most effective and efficient means of accomplishing those management functions.

The forest manager must be aware of the risk of water contamination and apply the following considerations:

1. The basic federal law regulating pesticides and their use is the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). The Michigan Pesticide Control Act further regulates use, handling and application of pesticides. Additional laws pertaining to pesticide uses, transport and application exist.
2. All pesticides are classified for "general" or "restricted" use. Restricted pesticides may be used only under supervision of certified applicators. Pesticide users need to be familiar with the laws and its regulations pertaining to certification and proper use of pesticides.
3. Follow the directions and heed all precautions on the labels. Store pesticides in original containers in secured areas, out of reach of children and animals, and away from food and feed.
4. Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.
5. Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment as specified on the container/label.

6. Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides.
7. The use of returnable pesticide containers is recommended. Otherwise, dispose of empty pesticide containers promptly, in a landfill licensed to accept toxic materials.

B. WILDFIRE DAMAGE CONTROL AND RECLAMATION

The prevention of all wildfire on forested land is a desirable goal. Where wildlife occurs, the first and foremost concern is to control the fire and limit the damage done.

Forest fire suppression measures themselves can add to the problem of water quality protection.

The loss of vegetative cover, destruction of soil holding features of root masses, the creation of a carbon layer in place of organic top layer of soil, and the exposure of bare mineral soil, is a combination that makes the area burned a highly erodible one. The effects of suppression efforts and equipment operations necessary to control and stop the fire can magnify the erosion problem. The following are specifications for reclamation of burned areas.

1. Bare mineral soil should be re-vegetated and areas where the tree cover has been killed or severely degraded should be regenerated with tree species appropriate for the soil conditions.
(See Table 5 and Chapter 5, A.3. and B.1., and 2.)
2. First priority for re-vegetation and re-forestation are all areas adjacent to banks of surface water bodies so that the buffer strip function is re-established. Until site stabilization occurs, the use of silt fences may be necessary.
3. Fire lines should be stabilized and re-vegetated. Other areas altered by suppression equipment operations should be repaired and re-vegetated as necessary.
(See Table 5 and Chapter 5, A.1. and B.1. and 2.)
(See Appendix A)
4. Where fire lines cause surface water to channelize and flow directly toward or into a water body, water bars should be placed in the fire line at the spacing indicated in Table 3.
5. Access road surfaces will be repaired and stabilized as necessary and existing water and erosion control structures cleaned and repaired if damaged during suppression work.

C. LIVESTOCK EXCLUSION FROM FOREST LAND

Where farm animals and other domesticated livestock can have access to forested areas, there is a high risk of destruction of plant materials (forbs, shrubs and trees) and the destabilization of forest and woodlot soils by grazing and trampling of the animals. Livestock trampling of stream banks and stream beds directly causes stream sedimentation and destruction of aquatic habitat.

Where livestock pasture lands adjoin forested lands, fencing or other physical barriers of access to the forest lands are necessary. Where shade and wind protection for the livestock are an important considerations, shade trees and shelter plantings should be scattered across the pasture and at least 100 feet distance from the forest edge and from any stream bank.

(See Chapter 5, A.1. and 3., B.1. and 2., C.)

Michigan's Commercial Forest Act (PA 94, 1925) prohibits grazing on all land which has been approved for listing under the Act.

Glossary

Access road: A temporary or permanent access route for vehicles into forest land.

Alignment: The horizontal route or direction of an access road. It is made up of straight line tangent sections and curves.

Angle of repose: The maximum slope or angle at which a material such as soil or loose rock remains stable.

Barriers: Obstructions to pedestrian, horse, or vehicular traffic. They are intended to restrict such traffic to a specific location.

Berm: A low earth fill constructed in the path of flowing water to divert its direction, or constructed to act as a counter-weight beside the road fill to reduce the risk of foundation failure.

Best management practices (BMP's): Implies a practice or combination of practices, that is determined to be the most effective, practicable (including technological, economic and institutional considerations) means of preventing or reducing the amount of water pollution generated by non-point sources. Management Practices properly applied will maintain a water quality level compatible with water quality goals.

Borrow pit: That area from which soil is removed to build up the road bed, sometimes directly adjacent and parallel to a road.

Broad-based dip: A surface drainage structure specifically designed to drain water from a permanent road while allowing vehicles to maintain normal travel speeds.

Buffer strip: An area of land adjacent to a water body which acts to trap and filter out suspended sediments, nutrients and chemicals before reaching surface waters. Harvesting and other forest management activities are permitted in the strip as long as the functional integrity of the strip is maintained. Shade from the strip may also reduce thermal pollution of an adjacent stream.

Check dam: A small dam constructed in road side ditch, a gully or other small watercourse to decrease the stream-flow velocity, minimize channel scour and promote deposition of sediment.

Corduroy: Logs placed over a swamp to reinforce the natural root mat for the purpose of minimizing the risk of settlement or foundation failure of a temporary road.

Culvert: A conduit through which surface water can flow under roads.

Cut-and-fill: Process of earth moving by excavating part of an area and using the excavated material for adjacent embankments or fill areas.

Dips: Economical, relatively trouble free structures for providing effective drainage of woods roads. Dips are considerably lower in cost than culverts, so time spent in careful construction is well justified.

Disking: A site preparation system where a heavy harrow with large disks is pulled over a site in order to eliminate competing vegetation.

Diversion ditch: A channel with a supporting ridge on the lower side constructed across a slope for the purpose of intercepting surface runoff.

Energy dispatchers: Materials or structures, placed at the discharge end of a culvert or ditch, which interrupt and spread the flow of water, thus reducing the water's power to cause erosion.

Erosion: The process by which soil particles are detached and transported by water, wind and gravity to some down slope or downstream point.

Felling: The process of severing trees from stumps.

Filter Strip: See Buffer Strip.

Fireline: A barrier used to stop the spread of fire constructed by removing fuel or rendering fuel un-flammable by use of water or fire retardants.

Ford: Submerged stream crossing where tread is reinforced to bear intended traffic. A place where a perennial or intermittent stream may be crossed by vehicle.

Forest floor: All dead vegetable matter on the mineral soil surface in the forest, including litter and unincorporated humus.

Grade: The slope of a road or trail expressed as a percent of change in elevation per unit of distance traveled.

Groundwater: The subsurface water supply in the saturated zone below the level of the water table.

Harvesting: The felling, loading, and transportation of forest products, roundwood or logs.

Integrated pest management (IPM): An ecological approach to pest management in which all available necessary techniques are consolidated into a unified program so that pest populations can be managed in such a manner that economic damage is avoided and adverse side effects are minimized.

Intermittent stream: A stream or portion of a stream that flows only in direct response to precipitation. It is dry for a large part of the year.

Loading: The act of placing material on a vehicle for further transport.

Logging debris (slash): That unwanted, unutilized, and generally unmarketable accumulation of woody material in the forest such as limbs, tops, cull logs, and stumps, that remain as forest residue after timber harvesting.

Mulching: Providing any loose covering for exposed forest soil, using organic residues, such as grass, straw or wood fibers to protect exposed soil and help control erosion.

Nonpoint source pollution: Pollution that enters a water body from an ill-defined or diffuse origin on the watershed and does not result from discernable, confined, or discrete conveyances.

Nutrients: Mineral elements in the forest ecosystem, such as nitrogen, phosphorus or potassium, that are naturally present or may be added to the forest environment by forest practices such as fertilizer or fire-retardant applications. Substances necessary for the growth and reproduction of organisms. In water, those substances that promote growth of algae and bacteria; chiefly nitrates and phosphates.

Ordinary high water mark: An elevation which marks the boundary of the lake, marsh or stream bed. It is the highest level at which the water has remained long enough to leave its mark upon the landscape. Generally, it is the point where the natural vegetation changes from predominately aquatic to predominately terrestrial.

Perennial stream (Permanent stream): A stream that maintains water in its channel throughout a majority of the year.

Pesticides: Chemical compounds or biological agents used for the control of undesirable plants, animals, insects or diseases.

Prescribed burning: Skillful application of fire to natural fuels that will allow confinement of the fire to a predetermined area and at the same time will produce certain planned benefits.

Rake: A site preparation tool normally mounted on the front of a crawler tractor, used to remove trees, stumps, roots and slash from a future planting site.

Riprap: A layer of boulders or rock fragments placed over a soil to protect it from the erosive forces of flowing water.

Runoff: In forest areas, that portion of precipitation that flows from a drainage area on the land surface or in open channels.

Scarification: The process of removing the forest floor or mixing it with the mineral soil by mechanical action preparatory to natural or direct seeding or the planting of tree seedlings.

Sediment: Solid material that is in suspension, is being transported, or has been moved from its site of origin.

Severe Erosion Hazard: A rating in the classification of soils indicating the relative risk of soil loss in well managed forest land. A severe rating indicates the need for intensive management, or special equipment and methods to prevent excessive soil loss.

Silt fence: A fence made of geotextile and installed to prevent the off-site movement of silt material.

Site preparation: A forest activity to remove unwanted vegetation and other material, and to cultivate or prepare the soil for reforestation.

Skidding: The act of moving trees from the site of felling to a loading area or landing. Skidding may be accomplished by tractors, horses, or specialized logging equipment.

Skid trails: A temporary pathway over forest soil to drag felled trees or logs to a landing.

Turnout: A widened space in a road to allow vehicles to pass one another and which slopes away (downhill) from the road. Also, a drainage ditch which drains water away from roads.

Water bar: A diversion ditch and/or hump across a trail or road tied into the uphill side for the purpose of carrying water runoff into the vegetation, duff, ditch, or dispersion area so that it does not gain the volume and velocity which causes soil movement and erosion.

Water pollution: Any introduction of foreign material into water or other impingement upon water which produces undesirable changes in the physical, biological, or chemical characteristics of that water.

Watershed: The surrounding land area that drains into a lake, river or river system.

Waters of the State: Any surface or underground waters, except those surface waters which are not confined but are spread and diffused over the land. This includes all lakes, ponds, marshes, rivers, streams, ditches, springs and waters from underground aquifers, regardless of their size or location.

Wetlands: Geographic areas characteristically supporting wetlands vegetation or aquatic life and commonly referred to as a bog, swamp or marsh.

Wildfire: Uncontrolled fires occurring in forest land, brushland, and grassland.

Windrow: Slash, residue and debris raked together into piles or rows.

STATE AND FEDERAL LAWS RELATED TO NONPOINT SOURCE POLLUTION CONTROL WHICH REQUIRE LAND OWNER PERMITS

Regulatory Laws – State of Michigan

1. **Part 31, Water Resource Protection (Floodplain Regulatory Authority), of the Natural Resources and Environmental Protection Act (NREPA), 1994 P.A. 451, as amended.**

A Part 31 permit is required for any occupation, construction, filling, or grade change within the 100-year floodplain of a river, stream, drain, or lake. Bridges and culverts are considered an occupation of the floodplain, as are activities that involve storage of materials in the floodplain. A 100-year flood has a one (1) percent chance of occurring or being exceeded in any given year. These activities are regulated by a permit system with the purpose of ensuring that the channels and floodways are kept clear and uninhabited and that structures placed outside the floodway are properly protected from flood damage. The floodway includes the stream channel and that portion of the floodplain that is required to convey the flow of floodwater. Structures that are placed outside of the floodway portion of the floodplain must be properly protected from flood damage. This can be accomplished by elevating structures above the 100-year floodplain elevation or by designing the structures to be water tight without human intervention.

2. **Part 91, Soil Erosion and Sedimentation Control, of NREPA, 1994 P.A. 451, as amended.**

The purpose of Part 91 is to prevent soil erosion and to protect the waters of the state from sedimentation. A permit is required for any earth change that disturbs one or more acres of land OR that is within 500 feet of a lake or stream. Plowing and tilling for crop production and integral activities associated with logging and mining do not require permits. Access roads leading to or from a logging area, and ancillary and support activities associated with logging and mining, are subject to permits.

Whether a permit is required or not, the landowner is responsible for preventing off-site sedimentation. Activities that result in sedimentation to the waters of the state are a violation of Part 91 and are subject to enforcement actions.

The counties are primarily responsible for issuing Part 91 permits. Prior to obtaining a permit, the landowner, or his/her designated agent, must submit an application and comprehensive soil erosion and sedimentation control plan to the appropriate county agency.

3. **Part 301, Inland Lakes and Streams, of NREPA, 1994 P.A. 451, as amended.**

The intent of the Inland Lake and Stream Protection Program is to protect the integrity of the land/water interface, that correlative rights of other riparian owners, and public trust in the inland waters of the state. Road and pedestrian

crossings, as well as utility crossing that disturb land below the ordinary high water mark are examples of common projects that require a Part 301 permit. Astomwater outfall, with or without streambank or streambed protection (riprap), stream relocations and enclosures are also examples of projects requiring a permit.

4. **Part 303, Wetlands Protection, of NREPA, 1994 P.A. 451, as amended.**

Part 303, defines a wetland as *"land characterized by the presence of water at a frequency and duration sufficient to support, and that under normal circumstances does support, wetland vegetation or aquatic life, and is commonly referred to as a bog, swamp, or marsh."*

The following activities are prohibited in wetlands unless a Part 303 permit has been obtained from the MDEQ:

- Deposit or permit the placing of fill material in a wetland.
- Dredge, remove, or permit the removal of soil or minerals from a wetland.
- Construct, operate, or maintain any use or development from a wetland.
- Drain surface water from a wetland.

Regulated wetlands are defined in Part 303 and associated administrative rules.

5. **Part 323, Shorelands Protection and Management, of NREPA, 1994 P.A. 451, as amended.**

This program provides for the designation and proper management of environmental areas, high-risk erosion areas and flood risk areas along the Great Lakes shoreline. These areas include coastal wetlands and the adjacent uplands that provide habitat and nursery for fish and wildlife. A Part 323 permit is required for certain activities in a designated environmental area.

6. **Part 353, Sand Dunes Protection and Management, of NREPA, 1994 P.A. 451, as amended.**

The designated critical dune areas along the Great Lakes shoreline are areas where the most unique and fragile sand dunes are found. This program minimizes the impact of development on these critical dune areas. A permit is required for all proposed new uses in designated critical dune areas mapped in the "Atlas of Critical Dune Areas" prepared by the MDEQ.

7. **Part 305, Natural Rivers Act, of NREPA, 1994 P.A. 451, as amended.**

This statute requires Department approval of plans for the location and construction of any utility or publicly provided facility, including roads, bridges and culverts, within a designated Natural River area. Each designated river system is managed according to a long-range management land, which outlines the specific manner in which lands and waters are to be managed to protect the unique river values. Tributaries area also controlled. All development and land uses are regulated within 400 feet of designated streams by a combination of activities including State and local zoning.

8. **Part 515, Forest Protection and Forest Fires Act, of NREPA, 1994 P.A. 451, as amended.**

This Act establishes the machinery to protect the forest from fires. It applies to all forest land; timbered, potential timber producing, cutover or burned timber land or grasslands not including farmland. It requires a permit for burning on or adjacent to forestland except for domestic purposes, and when the ground is snow covered.

Act 329 and the permit process serve to inhibit indiscriminate burning in Michigan. Prescribed burning requires a permit.

9. **Part 17, Michigan Environmental Protection Act, of NREPA, 1994 P.A. 141, as amended.**

This Act provides for the protection of air, water, and other natural resources, and the public trust associated with those resources. It provides the right to any person to bring an action against another person, agency, corporation, and political subdivision for conduct that may pollute, impair or destroy air, water, or other natural resources.

Exhibit 1
FOREST LAND EMERGENCY SPILL RESPONSE PLAN SHEET
(For logging crews/timber management crews)

This plan sheet for handling spills of fuels and lubricants should be completed as appropriate to the location of any timber management job site. A copy of a completed plan sheet should be provided to each member of a job site crew and discussed with each as to that person's role in spill response. For materials other than fuels or lubricants, additional special handling or safety measures may be necessary. Identify those materials, determine the proper handling procedures and list them with this plan. It is important to keep a minimum amount of spill response equipment available on the job site and on vehicles transporting materials. At a minimum, that should include shovels, rubber gloves, and safety glasses. Containers, such as 55 gallon drums should be available on the job site to collect and remove spilled materials.

When spills occur, the following emergency response steps should be taken:

- Step 1: Insure the safety of each person on the job site. Tend to any injuries. Evacuate the area where the danger of explosion or exposure to toxic fumes is high.
- Step 2: Contain the spill. If the material is spilled directly into a water body (Lake, stream or wetland) contact the appropriate authority* immediately and assist in the containment and retrieval of spilled materials. If material is spilled on the ground, dikes and dams should be build to keep the material from spreading until it can be retrieved. When material is spilled on porous soils, it must be retrieved quickly to prevent contamination of groundwater.
- Step 3: Retrieve the spilled material, remove it from the site and deposit at an appropriate disposal site.

*When a spill is large and assistance is needed to either contain it, retrieve it, transport it or dispose of it, appropriate authority must be contacted. The Department of Natural Resources Pollution Emergency Alerting System (PEAS) is available 24 hours a day; 1-800-292-4706. A number of spill response contracting firms are available throughout the state. Contact can be initiated with other local authorities such as; DNR District Office, State Police, county emergency coordinator and local township fire department.

Persons or agencies to contact pertinent to a given job site

_____ (Location) are:

Local Response Agency	Contact Person	Phone
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- 1.
- 2.
- 3.
- 4.
- 5.

APPENDIX A
CRITICAL AREA PLANTING IN FORESTED AREAS

The purpose of this practice is to revegetate critical areas in forested areas to stabilize the soil and reduce damage from sediment and runoff to downstream areas. This practice is applicable on sediment-producing, highly erodible or severely eroded areas; such as skid trails, stream crossings, log landing, cuts, fills, and denuded or gullied areas where vegetation is difficult to establish.

Protection During Establishment

Divert runoff water away from the area being stabilized whenever possible to protect the area until the vegetative cover is established. Control water runoff by culverts, water bars and diversion ditches.

Critical areas of concentrated water flow, such as an increase in channel grade, a change to a more erosive soil type, or other erosion problems, will require special attention. The use of jute netting, excelsior blanket, mulchnet, sod (staked down), or other acceptable erosion control blankets should be considered.

Site Preparation

Provide the best possible soil conditions for seeding. Wherever possible, stockpile and replace topsoil after grading. The seedbed, immediately before seeding, should be firm not so compact as to prohibit covering seed or securing adequate germination or root penetration. Tillage implements should be used if necessary to provide at least a three inch depth of firm but friable soil, free of large clods and stones. On slopes steeper the 3:1, the three inch minimum depth of seedbed preparation is not required, but the soil should be worked enough to ensure sufficient loose soil to provide an adequate seed cover.

Fertilizer

Apply a minimum of 500 pounds per acre of 12-12-12 or equivalent of commercial fertilizer (12 pounds per 1,000 square feet).

Seeding

Use a cultipacker to firm the seedbed on areas not mulched and areas not firmed with the seeding equipment. Plant in a moist firm seedbed. Place seed from 1/4 inch to not more than 1/2 inch deep. Tables 1 and 2 recommend seeding times and mixtures. Long term vegetative cover is preferred on most sites to help insure perennial vegetation and long term erosion control. Temporary mixtures should be added to the long term mixtures where it is particularly important to achieve immediate vegetative cover or when soil temperatures are cooler than 50°.

Mulching

Mulch is extremely important on new seedings on slopes, droughty sands, clayey soils and on areas without topsoil.

Immediately after seeding, mulch all seeded areas steeper than 4:1 with unweathered small grain straw (preferably wheat) spread uniformly at the rate of 1 1/2 to 2 tons per acres, or 100 lbs. (2-3 bales) per 1,000 square feet.

Anchor mulch with one of the following methods:

1. Mulch anchoring tool. This tool has a series of flat, notched disks that punch and anchor the mulch material into the soil.
2. Mulch netting of lightweight, fibrous materials.
3. Excelsior Blanket may be used in lieu of other mulch in gutters, channels, or other areas of concentrated runoff.

Maintenance of Seedings

Vehicular traffic must be controlled so as not to leave depressions or deposits of soil which can result in concentrations of water and formation of gullies.

Appendix A (Cont.)

Table 6: TEMPORARY VEGETATIVE COVER

PLANTING DATES			KIND OF SEED	SEEDS & RATES	
Lower Penin* S. of US 10 Zone 1	Lower Penin* N. of US 10 Zone 2	Lower Penin* Zone 3		Per 1,000 Sq. Feet	Per Acre
April 1 to Sept. 15	April 15 to Aug. 1	May 1 to Aug. 1	Oats, Barley or Perennial Ryegrass	2 lbs. 1/2 lb.	3 bu. 20 - 25 lbs.
Aug. 1 to Oct. 15	Aug. 1 to Oct. 10	Aug. 1 to Oct. 1	Rye or Perennial Ryegrass	3 lbs. 1/2 lb.	2-3 bu. 20-25 lbs.
Sept. 20 to Oct. 15	Sept. 10 to Oct. 10	Sept. 1 to Oct. 1	Wheat	3 lbs.	2-3 bu.

*Peninsula

Appendix A (Cont.)

Table 7: LONG TERM VEGETATIVE COVER

PLANTING DATES		
Zone 1 Lower Peninsula South of US 10	Zone 2 Lower Peninsula North of US 10	Zone 3 Upper Peninsula
April 20 to May 20	May 1 to June 10	May 1 to June 15
or	or	or
August 10 to October 1	August 1 to September 20	August 1 to September 20

*Peninsula

SEEDING MIXTURES AND RATES

	MINIMUM SEEDING MIXTURE	LBS/1000 SQ. FT.	LBS/ACRE
Well Drained Sand & Coarse Textured Soils	Creeping Red Fescue Perennial Ryegrass Tall Fescue	1/2 lb. 1/4 lb. 1/2 lb.	22 lbs. 11 lbs. 22 lbs.
Well & Moderately Well Drained Sandy Loams, Loam, Clay, or Clay loam	Creeping Red Fescue Perennial Ryegrass Tall Fescue Redtop	1/2 lb. 1/4 lb. 1/2 lb. 1/4 lb.	22 lbs. 11 lbs. 22 lbs. 11 lbs.
Somewhat Poor or Poorly Drained Soils	Seaside Bentgrass Smooth Brome grass Tall Fescue	1/4 lb. 1/2 lb. 1/2 lb.	11 lbs. 22 lbs. 22 lbs.